Installation, Operation and Maintenance Instructions

1200 °C Smelting Crucible Furnace - SCF Model: 1
2416 Controller

SCF 1 + 2416 Controller
Contents

This manual is for guidance on the use of the Carbolite Gero product specified on the front cover. This manual should be read thoroughly before unpacking and using the furnace or oven. The model details and serial number are shown on the back of this manual. Use the product for the purpose for which it is intended.

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1.0 Symbols and Warnings

1.1 Switches and Lights

Instrument switch: when the instrument switch is operated the temperature control circuit is energised.

Heat light: the adjacent light glows or flashes to indicate that power is being supplied to the elements.

1.2 General Warnings

DANGER – Electric shock. Read any warning printed next to this symbol.
WARNING: Risk of fatal injury.

DANGER – Hot surface. Read any warning printed next to this symbol.
WARNING: All surfaces of a product may be hot.

DANGER – Read any warning printed next to this symbol.

Caution – Double Pole/Neutral Fusing
2.0 Installation

2.1 Unpacking & Handling

When unpacking or moving the product, always lift by its base; do not use the door or any other projecting cover or component to support the equipment when moving it. Use a fork lift or pallet truck to move the product; position the product on a level surface and use an adequate number of personnel to safely move the product into position.

Carefully remove any packing material from inside and around the product before use. Avoid damaging the surrounding insulation when removing packing materials.

NOTE: This product contains Refractory Ceramic Fibre (also known as Alumino Silicate Wool - ASW). For precautions and advice on handling this material see section 8.2.

2.2 Siting and Setting Up

Place the product on a level surface in a well ventilated area.

Site away from other sources of heat and on a non-flammable surface that is resistant to accidental spillage or hot materials.

The surface on which the equipment is mounted should be stable and not subject to movement or vibrations.

The height of the mounting surface is important to avoid operator strain when loading and unloading samples.

Unless otherwise stated elsewhere in this manual, ensure that there is at least 150 mm of free space around the back and sides of the product. Clear space is required above the product to dissipate heat.
Depending on the application of the product, it may be appropriate to position it under an extraction hood. Ensure the extraction hood is switched on during use.

Ensure that the product is placed in such a way that it can be quickly switched off or disconnected from the electrical supply.

Under no circumstances should any objects be placed on top of the product. Always ensure that any vents on the top of the product are clear of any obstruction. Always ensure all cooling vents and cooling fans (if fitted) are clear of any obstruction.

### 2.3 Hearth

The hearth and chamber are supported during transport by packing foam. Remove and dispose of this packaging.

### 2.4 Air Inlet Tube

Carefully insert the air inlet tube into the furnace until it the top of the tube is level with the base of the chamber as shown in the image below.
2.0 Installation

Tighten the wire onto the tube ensure that the wire is positioned over the groove in the tube. Tighten both screws and ensure there is no slack in the wire.

If the product is to be used to heat substances that emit fumes, a fume extraction duct may be placed directly above the furnace.

Do not make a sealed connection to the product chimney as this causes excessive airflow through the chamber and results in poor temperature uniformity.

A heatproof drip tray will be supplied to prevent corrosion to the floor underneath the furnace. The tray should be placed directly under the air inlet as shown in the image below.
2.5 Electrical Connections

Connection by a qualified electrician is recommended.

The model covered in this manual has three internal circuits and is normally supplied for connection to a three phase power supply. This may be either star or delta, but a product must only be connected to the type and voltage of supply for which it was made. If the product is ordered for a single phase supply, this may be Live to Neutral reversible or non-reversible, or Live to Live.

Check the product rating label before connection. The supply voltage should agree with the voltage on the label and the supply capacity should be sufficient for the current on the label.

The supply should be fused at the next size equal to, or higher than the current on the label. A table of the most common fuse ratings is also given towards the back of this manual. When the mains cable is factory fitted, internal fuses are also fitted. It is essential that the operator ensures that the product is correctly fused.

Products with a factory fitted supply cable are designed to be wired directly to an isolator or fitted with a line plug.
2.0 Installation

Products without a factory fitted supply cable require a permanent connection to a fused and isolated supply. The product's electrical access panel should be temporarily removed, and connections made to the internal terminals.

If the product is to be connected by line plug. The plug should be within reach of the operator and should be easy to remove.

When connecting the product to an isolating switch ensure that both conductors (single phase) or on all live conductors (three phase), and should be within reach of the operator.

The supply MUST incorporate an earth (ground).

Electrical Connection Details:

<table>
<thead>
<tr>
<th>Supply</th>
<th>Terminal Label</th>
<th>Cable Colour</th>
<th>Live - Neutral</th>
<th>Reversible or Live-Live</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-phase</td>
<td>L</td>
<td>Brown</td>
<td>to live</td>
<td>to either power conductor (For USA 200-240V, connect L1)</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Blue</td>
<td>to neutral</td>
<td>to the other power conductor (For USA 200-240V, connect L2)</td>
</tr>
<tr>
<td></td>
<td>PE</td>
<td>Green/Yellow</td>
<td>to earth (ground)</td>
<td>to earth (ground)</td>
</tr>
</tbody>
</table>

2- or 3-phase

<table>
<thead>
<tr>
<th>Supply</th>
<th>Terminal Label</th>
<th>Cable Colour</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>Black</td>
<td></td>
<td>to phase 1</td>
</tr>
<tr>
<td>L2</td>
<td>Black</td>
<td></td>
<td>to phase 2</td>
</tr>
<tr>
<td>L3</td>
<td>Black</td>
<td></td>
<td>to phase 3 <strong>(except 2-phase)</strong></td>
</tr>
<tr>
<td>N</td>
<td>Light Blue</td>
<td></td>
<td>to neutral <strong>(except delta)</strong></td>
</tr>
<tr>
<td>PE</td>
<td>Green/Yellow</td>
<td></td>
<td>to earth (ground)</td>
</tr>
</tbody>
</table>

2.6 Voltage and Power Limit

When first starting up the product, check the setting of the OP.Hi parameter (see the controller instructions) and compare it with the data in section 11.0 towards the back of this manual.

If the power limit setting is incorrect for the voltage of the electrical supply, change it. This must be done immediately if the setting of OP.Hi is higher than it should be.
3.0 2416 Controller

3.1 Description

This manual applies to the 2416, 2416CG and 2416P8 controllers. Special customer requirements may result in changes to the available parameters and the navigation diagram. It is not possible to list all the possibilities in this manual.

2416CG Controller

The Eurotherm model 2416CG is a digital instrument with PID control algorithms which may be used as a simple controller or an 8-segment programmer. The 2416P8 is an eight-program model in which the programs can be stored independently or can be linked by a “call” parameter to form a single long program.

The 2416 Controller features:

- Easy use as a simple temperature controller, where on setting the required temperature the controller immediately attempts to reach and maintain it. Fig.1 indicates the type of temperature response when used in this way.
- By using one program segment, the control can be extended to include ramp-to-set-point. Fig.2 shows the effect.
- Alternatively, the 2416 Controller may be used as an 8-segment programmer, with each segment being a "Ramp", a "Step", a "Dwell", or "End". The program can be set to cycle if required. See fig. 3.
- Optional “modules” are available, in particular:
  - RS232 and RS432/485 digital communications modules;
  - Analogue communication modules;
  - “PDSIO” modules for communication with other controllers of similar or higher specification, for example, to allow cascade control;
  - Alarm modules, which can be used to drive visible or audible alarms, or to provide volt-free contacts for customer use.
Fig 1 - Simple Control

Fig 2 - Control with Ramp-to-Setpoint
Seg 1 = Ramp
Sep 2 = End (Dwell)

Fig 3 - A Program

Key

| T1 | Temperature |
| T2 | Time        |
| SP | Setpoint    |
| AT | Actual Temperature |
| WSP| Working Setpoint |
| R  | Ramp        |
| D  | Dwell       |
| S  | Step        |
| E  | End         |
3.2 Operation

Most Carbolite Gero products are fitted with an instrument switch which cuts off power to the controller and other parts of the control circuit. See section 6.0 for operating instructions.

To operate the 2416 Controller there must be power to the furnace or oven and the instrument switch must be on. If a time switch is included in the furnace or oven circuit, this must be in an ON position.

2416CG - Operation

When switched on, the controller lights up, goes through a short test routine and then displays the measured temperature and setpoint. Depending on its state when it was last switched off, it may start to control to the current setpoint of program. The output light glows or flashes to indicate that the control is occurring.

The buttons and indicators are used for the following purposes:

Key

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Output Light</td>
</tr>
<tr>
<td>B</td>
<td>Not Used</td>
</tr>
<tr>
<td>C</td>
<td>Page</td>
</tr>
<tr>
<td>D</td>
<td>Scroll</td>
</tr>
<tr>
<td>E</td>
<td>Down</td>
</tr>
<tr>
<td>F</td>
<td>Up</td>
</tr>
<tr>
<td>G</td>
<td>Run/Hold</td>
</tr>
<tr>
<td>H</td>
<td>Setpoint Temperature (SP)</td>
</tr>
<tr>
<td>I</td>
<td>Measured Temperature</td>
</tr>
</tbody>
</table>
### 3.0 2416 Controller

<table>
<thead>
<tr>
<th>Auto/Manual</th>
<th>Disabled.</th>
<th>The unit is always in 'Auto' mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN/HOLD</td>
<td>-</td>
<td>Used to start, stop or pause a program. Short presses cause it to alternate between 'Run' and 'Hold', but if it is held for 2 seconds the programmer goes into 'Reset' mode where it behaves as a simple controller.</td>
</tr>
<tr>
<td>Up + Down</td>
<td>▲ + ▼</td>
<td>To adjust the value of a parameter. Used to change the setpoint when the unit is being used as a simple controller ('Reset' mode). Holding down gives an accelerated parameter change.</td>
</tr>
<tr>
<td>Page</td>
<td>□</td>
<td>Allows access to the parameters within the controller; most lists and parameters are hidden from the operator as they contain factory-set values which should not be altered. A single press of the page key shows the temperature units, normally °C; further presses reveal the lists indicated in the Navigation Diagram.</td>
</tr>
<tr>
<td>Scroll</td>
<td>□</td>
<td>Allows access to the parameters within a list. A single press displays the temperature units; further presses reveal the parameters in the current list. Some parameters are display-only, others may be altered by the operator.</td>
</tr>
<tr>
<td>Page + Scroll</td>
<td>□ + □</td>
<td>Press together to cause an immediate return to the 'Home List'</td>
</tr>
<tr>
<td>Run &amp; Hold</td>
<td></td>
<td>Indicate the current mode: 'Run', 'Hold', or 'Reset' (Reset: both lights off). 'Run' flashes at the end of a program. 'Hold' flashes during holdback (when the program is paused to allow the temperature to catch up with a heating or cooling rate which is too fast).</td>
</tr>
<tr>
<td>Output Indicator</td>
<td>OP1</td>
<td>Indicates that the programmer is calling for heat to be supplied. OP2 is not used.</td>
</tr>
<tr>
<td>SP2 and REM</td>
<td></td>
<td>Not generally used; indicate 'Second' or 'Remote' setpoint in use.</td>
</tr>
</tbody>
</table>

### Operation as a Simple Controller

Press RUN/HOLD for 2 seconds to go into 'Reset' mode. Use down ▼ or up ▲ from the 'Home List' (i.e. when the temperature is displayed) to adjust the setpoint. The unit starts to control in the way indicated in Fig. 1.

---

Note that to use the Ramp Rate feature, as in Fig. 2, it is necessary to create a program. See the following sections.
3.3 Programming

Note that a currently active segment cannot be altered - put the programmer into 'Hold' or 'Reset' whenever it is necessary to do so to alter a parameter. Go into 'Reset' mode (i.e. press RUN/HOLD for 2 seconds) before starting to create or modify a program.

Press page \( \text{n} \) until 'ProG LiSt' is displayed.

Press scroll \( \text{n} \) to reveal the 'Holdback' and 'Loop Count' parameters. See sections 3.3.3 and 3.3.4 for a description of these.

Press scroll \( \text{n} \) to display 'SEG.n' (segment number); use down \( \text{▼} \) or up \( \text{▲} \) to move to the segment to be adjusted or created.

Press scroll \( \text{n} \) to see the 'tYPE' (segment type); use down \( \text{▼} \) or up \( \text{▲} \) to change the required segment type – see the table below.

Press scroll \( \text{n} \) to access the parameters appropriate to the type of segment chosen – see the following table – and use down \( \text{▼} \) or up \( \text{▲} \) to alter the values.

The final segment should be of type 'End', unless all program segments are used. Segments after 'End' are ignored.

<table>
<thead>
<tr>
<th>Segment Type</th>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>RmP.r</td>
<td>TGt</td>
<td>The target setpoint for this segment</td>
</tr>
<tr>
<td></td>
<td>rATE</td>
<td>The ramp rate (rate of temperature change) in °/ minute</td>
</tr>
<tr>
<td>RmP.t</td>
<td>TGt</td>
<td>The target setpoint for this segment</td>
</tr>
<tr>
<td></td>
<td>dur</td>
<td>The duration of the segment. The controller calculates the rate of temperature rise necessary to achieve this duration.</td>
</tr>
<tr>
<td>Dwel</td>
<td>dur</td>
<td>The time in minutes to remain at the previous target temperature. 10ths of a minutes are allowed.</td>
</tr>
<tr>
<td>SteP</td>
<td>tGt</td>
<td>A new target temperature to be achieved as quickly as possible.</td>
</tr>
<tr>
<td>CaLL</td>
<td>PrG.n</td>
<td>Only applicable to 2416P8. Calls another stored program given by 'PrG.n' as a subroutine, running it the number of times given by 'cyc.n'.</td>
</tr>
<tr>
<td></td>
<td>cyc.n</td>
<td></td>
</tr>
<tr>
<td>End</td>
<td>End.t</td>
<td>'Dwel' holds the temperature at the last target value. 'RSET' returns to simple controller operation; if the setpoint is set to zero then this effectively turns the heating off. 'SoP' sets the power to 0% – use of this is not recommended.</td>
</tr>
</tbody>
</table>

3.3.1 Programming Tips

Make sure the basic setpoint is set to zero to avoid unexpected heating at the end of a program.
If all segments are used so that there is no 'End' segment, then on completion the program automatically goes into 'Dwell'.

Dwell segments of length zero can be included. This is a way of allowing space for future program changes.

For an example of program creation, see section 3.3.6.

3.3.2 Multi-program model (2416P8)
The 'Program Edit' list contains the extra parameter 'PrG.n' and the 'Run' list contains the extra parameter 'PrG'. These features allow selection of the program to be edited or to be operated.
The extra segment type 'cALL' allows one program to call another as a subroutine; use this feature to create one or more long programs.

3.3.3 Holdback
"Holdback' can be used to prevent the program from operating ahead of the actual heating or cooling.

In the program list, scroll to the 'Holdback' parameter and use down or up to set the holdback type as follows:

<table>
<thead>
<tr>
<th>Band</th>
<th>Holdback applies to both heating and cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lo</td>
<td>Holdback applies to heating only</td>
</tr>
<tr>
<td>Hi</td>
<td>Holdback applies to cooling only</td>
</tr>
<tr>
<td>Off</td>
<td>Holdback is off</td>
</tr>
</tbody>
</table>

Set 'Hb.V' to the value in °C beyond which holdback is to operate. Type 'BAnd' and a value of 10 °C is often a suitable combination, if holdback is required. In this case, if the actual temperature deviates outside ±10 °C from the working setpoint, the holdback lamp of the front of the controller flashes and the program is held up until the temperature comes within range again.

The standard setting for holdback is OFF.

3.3.4 Program Cycling
The 'Loop Count' parameter 'CYC.n' can be set to control the number of times the program is run.
If 'CYC.n' = 1, the program stops at the end segment.
If 'CYC.n' = 5 (for example), the program runs 5 times: at the 'End' segment it returns to segment 1, until the 5th time through when it stops.
If 'CYC.n' = cont, the program never ends: it cycles continuously.

3.3.5 Running a Program
Press Run/ Hold to light up the 'Run' light. The program starts to operate.

To view the progress of a program from the 'Home' list, press scroll to reveal the current segment ('SEG') and the total program time remaining in hours ('PrG.t').
For a more detailed view, press page \( \text{Page} \) to access the 'Run' list page and scroll \( \text{Key} \) to see its contents as shown in the Navigation Diagram below. Provided the unit is first put into 'Hold' mode, temporary changes may be made to parameters; these apply only until the program ends or is reset.

To pause a program, press Run/ Hold; the 'Hold' light comes on. To terminate a program, press Run/ Hold for 2 seconds; the 'Run' and 'Hold' lights go out.

While the program is operating, the working setpoint is shown in the lower display.

3.3.6 Program example

The following sequence of entries creates and runs the program.

1. Press page \( \text{Key} \) key until 'ProG LiSt' is displayed.
2. Press scroll \( \text{Key} \) until 'CYC.n' is displayed and use the arrow key to select 1.
3. Press scroll \( \text{Key} \) until 'SEG.n' is displayed and use the arrow key to select 1.
4. Press scroll \( \text{Key} \) until 'tYPE' is displayed and use the arrow key to select rmP.r.
5. Press scroll \( \text{Key} \) until 'rGt' is displayed and use the arrow key to select 600.
6. Press scroll \( \text{Key} \) until 'rAtE' is displayed and use the arrow key to select 5.0.
7. Press scroll \( \text{Key} \) until 'SEG.n' is displayed and use the arrow key to select 2.
8. Press scroll \( \text{Key} \) until 'tYPE' is displayed and use the arrow key to select dwEl.
9. Press scroll \( \text{Key} \) until 'dur' is displayed and use the arrow key to select 60.0.
10. Press scroll \( \text{Key} \) until 'SEG.n' is displayed and use the arrow key to select 3.
11. Press scroll \( \text{Key} \) until 'tYPE' is displayed and use the arrow key to select rmP.t.
12. Press scroll \( \text{Key} \) until 'tGt' is displayed and use the arrow key to select 400.
13. Press scroll \( \text{Key} \) until 'dur' is displayed and use the arrow key to select 60.0.
14. Press scroll \( \text{Key} \) until 'SEG.n' is displayed and use the arrow key to select 4.
15. Press scroll \( \text{Key} \) until 'tYPE' is displayed and use the arrow key to select 'dwEl'.'.
16. Press scroll \( \text{Key} \) until 'dur' is displayed and use the arrow key to select 30.
17. Press scroll \( \text{Key} \) until 'SEG.n' is displayed and use the arrow key to select 5.
18. Press scroll \( \text{Key} \) until 'tYPE' is displayed and use the arrow key to select rmP.r.
19. Press scroll \( \text{Key} \) until 'tGt' is displayed and use the arrow key to select 30.
20. Press scroll \( \text{Key} \) until 'rAtE' is displayed and use the arrow key to select 5.0.
21. Press scroll \( \text{Key} \) until 'SEG.n' is displayed and use the arrow key to select 6.
22. Press scroll \( \text{Key} \) until 'tYPE' is displayed and use the arrow key to select 'End'.
23. Press scroll \( \text{Key} \) until 'End.t.' is displayed and use the arrow key to select 'dwEl'.
24. Press the page \( \text{Key} \) key until you return to the main display.
25. Press the 'Run' key. The program operates.
3.4 Controller Options

As options can be ordered in a variety of combinations and for a variety of purposes, exact instructions are not given here. The full Eurotherm manual may be required to determine customer parameter settings. To reveal or hide parameters in the controllers it is necessary to go into configuration mode, a security code is needed. Please consult Carbolite Gero.

3.4.1 Digital Communications - RS232

If the RS232 option is supplied, the furnace is fitted with one sub-miniature D-socket connected to the controller comms module. RS232 is suitable for direct connection to a personal computer (PC) using a “straight through” cable as follows (the linked pins at the computer end are recommended but may not be necessary). The cable is usually 9-pin at the furnace end and 9-pin at the computer, but other alternatives are shown in parentheses.

<table>
<thead>
<tr>
<th>Product end of cable female (25-pin) 9-pin</th>
<th>RS232 Cable: product to PC</th>
<th>Computer end of cable 9-pin (25-pin) male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx (2) 3</td>
<td>________________________</td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>Tx (3) 2</td>
<td>________________________</td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com (7) 5</td>
<td>________________________</td>
<td>5 (7) Com</td>
</tr>
</tbody>
</table>

3.4.2 Digital Communications - RS485

If an RS485 option is supplied, the furnace is fitted with two D-sockets. Connection between products is by “straight” cable as follows:

<table>
<thead>
<tr>
<th>Product end of cable female (25-pin) 9-pin</th>
<th>RS485 Cable: product to PC</th>
<th>Computer end of cable 9-pin (25-pin) female</th>
</tr>
</thead>
<tbody>
<tr>
<td>- (2) 3</td>
<td>________________________</td>
<td>3 (2) Tx</td>
</tr>
<tr>
<td>+ (3) 2</td>
<td>________________________</td>
<td>2 (3) Rx</td>
</tr>
<tr>
<td>Com (7) 5</td>
<td>________________________</td>
<td>5 (7) Com</td>
</tr>
</tbody>
</table>

3.4.3 Comms Address

Typically the comms address is set to 1, but this can be changed. In the case of RS485 and multiple instruments it is necessary to set different addresses. To change the address value, access the level 2 list. In level 2 press the page key until the COMMS parameter is displayed. Press up ▲ down ▼ to select the address value.
3.4.4 Alarm Option

When an alarm board is fitted, which consists of a relay with voltage free contacts, for operator use, the contacts are taken to a panel plug on the control panel, wired as indicated:

![Diagram of alarm option with labels and connections]

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Temperature Controller</td>
</tr>
<tr>
<td>F</td>
<td>Fuse (2A)</td>
</tr>
<tr>
<td>S</td>
<td>Supply</td>
</tr>
<tr>
<td>L</td>
<td>Load</td>
</tr>
<tr>
<td>*</td>
<td>Normally open relay contacts</td>
</tr>
<tr>
<td>RO</td>
<td>Relay Output 240V 2A MAX</td>
</tr>
</tbody>
</table>

The purpose of the 2 amp fuse is to break the circuit to prevent overloading on the circuit due to high voltage.

The instrument configuration and parameters available to the operator depend on the customer requirements.

3.5 Temperature Controller Replacement

Before handling the controller: wear an anti-static wrist strap or otherwise avoid any possibility of damage to the unit by static electricity. Refer to the detailed instructions supplied with the replacement controller.

 Ease apart the two lugs at the side; grip the instrument and withdraw it from its sleeve; push in the replacement.
3.6 Navigation Diagram
This over-temperature controller is fitted and supplied ready to use by Carbolite Gero. It is a digital instrument with a latching alarm, requiring no additional panel controls. The controller features easy setting of over-temperature setpoint and reading of current temperature by the over-temperature sensor.

4.2 Operation

4.2.1 Controls

Most Carbolite Gero products are fitted with an instrument switch which cuts off power to the controller and other parts of the control circuit.

To operate the controller, power must be supplied to the product and the instrument switch must be on. If a time switch is included in the product circuit, this must be in the 'ON' position.

When an over-temperature condition occurs, the controller cuts the power to a contactor, which in turn cuts power to the heating elements. Power is not restored until the controller is 'reset'.

Some components will operate after the over-temperature feature isolates the power supply e.g. cooling fans will continue to operate, provided that there is a power supply to the product. In some cases the product may not do so, if other options (such as a door switch) are fitted.
4.2.2  Operation

When switched on, the controller lights up, goes through a short test routine and then displays the measured temperature or the over-temperature setpoint.

The page key  allows access to parameter lists within the controller.

A single press of the page key  displays the temperature units, normally set to °C; further presses reveal the lists indicated in the navigation diagram.

The scroll key  allows access to the parameters within a list. Some parameters are display-only; others may be altered by the operator.

A single press of the scroll key  in the 'Home' list displays the temperature units; further presses reveal the parameters in the current list indicated in the navigation diagram.

To return to the 'Home' list at any time, press page  and scroll  together, or wait for 45 seconds.

The down  and up  keys are used to alter the setpoint or other parameter values.

4.2.3  Over-Temperature Operation

Use down  and up  to alter the over-temperature setpoint. This should normally be set a little above the working temperature (for example 15 °C above). The product is supplied with the over-temperature set at 15 °C above the furnace or oven maximum working temperature.

Press scroll  twice view the present temperature as measured by the over-temperature controller. Press it twice, the first press shows the temperature units (°C).

4.2.4  Over-Temperature Alarm

If an over-temperature condition occurs, the OP2 indicator flashes and an alarm message 2FSH also flashes, alternating with the setpoint. Power to the heating elements is disconnected.

4.2.5  Resetting the Over-Temperature Alarm

To acknowledge the alarm press scroll  and page  together.

If the alarm is acknowledged while there is still an over-temperature condition, the OP2 indicator stops flashing but continues to glow. The 2FSH alarm continues to flash until the over-temperature condition is cleared (by the temperature falling), when normal operation resumes.

If the alarm is acknowledged when the temperature has dropped (or after the over-temperature setpoint has been raised) so that the over-temperature condition no longer exists, then the furnace or oven immediately resumes normal operation.

4.2.6  Sensor Break

The over-temperature cut-out system also operates if the over-temperature control thermocouple breaks or becomes disconnected. The message S.br flashes where the measured temperature is normally displayed.
4.3 Audible Alarm

If an audible alarm is supplied for use with the over-temperature controller, it is normally configured to sound on over-temperature condition and to stop sounding when the alarm is acknowledged as given in section 4.2.

Note: the alarm may sound during controller start-up.

4.4 Navigation Diagram

<table>
<thead>
<tr>
<th>HL</th>
<th>Home List</th>
<th>Page Key</th>
<th>Black = Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTSP</td>
<td>Over-Temperature Setpoint</td>
<td>Scroll Key</td>
<td>Dashed = Through to other options</td>
</tr>
<tr>
<td>AL</td>
<td>Access List</td>
<td>!</td>
<td>For factory access to list and parameters not available to the operator.</td>
</tr>
</tbody>
</table>
5.0 Time Switch

5.1 Digital Time Switch - Theben TR 635 top2

The Theben TR 635 top2 is a 7 day digital time switch with 84 memory locations each of which can contain a switching time for any or all or the days in a week. It is battery backed with approximately 10 years power reserve. The shortest switching interval is 1 minute.

A choice of languages is included. There is a real-time clock and a choice of daylight saving rules.

The facia features a digital display and four buttons as shown in the image.
**Important Note**
In the instructions below, "select" an item means the following:
Press the arrow keys (usually the right) until the item appears on the screen. Then press **OK**.

**Reset**
To reset press all four buttons simultaneously all stored programs can be retained or deleted. Normally avoid reset except to change the language, as follows.
Press all four buttons simultaneously. Then select the required language.
Set the time and date by pressing the arrow keys and using **OK**. After changing language it may be necessary also to change the daylight saving rules: see the next section.

**Setting the Time and Date (and Daylight Saving Rules)**
Press the MENU key then use the right arrow key to display TIME/ DATE and then press **OK**. Use the arrow keys and **OK** to set the time and date.
After setting the date, the next display shows the current SU – WI selection. To alter the daylight saving rules, press the arrow keys to select between six different countries or FREE or FIX DATE or NO SU-WI.
If FREE is chosen, a month and date entry sequence is entered: follow the display requests.

**Setting a Switch-On or Switch-Off Time**
A program entry comprises a function (on or off), a switching time and the days to which it applies.
Press MENU.
PROGRAM is displayed. Press **OK**.
NEW is displayed. Press **OK**.
Use the arrow keys to select ON (for switch on times) or OFF (for switch off times). Press **OK**.
HOUR is displayed. Use the keys to enter hour, minute and confirm by pressing **OK**.
MONDAY is displayed. Select the day required then press **OK**.
COPY is displayed. Press **OK** to copy the switching time to other days or use the arrow key to select SAVE.
Other choices are CHECK, MODIFY, CLEAR or END.

**Modifying or deleting a Switch-On or Switch-Off Time**
Press MENU.
PROGRAM is displayed. Press **OK**.
NEW is displayed. Use the arrow keys to select CHECK, MODIFY or DELETE. Press **OK** after selecting one of these options. If modifying confirm MODIFY HOUR by pressing
5.0 Time Switch

**OK.** The first of the switching times is shown. Use the keys to adjust the time and confirm by pressing **OK**.

Once the date and time memories are entered, the time switch automatically obeys them. Note that if the same time is used for an on as an off, off takes priority.

**Overriding the Program**
To change the present state between on and off, press MENU, select MANUAL. Within the MANUAL choices are PERMANENT ON; PERMANENT OFF; MANUAL ON; TIMER; HOLIDAY; RANDOM & END.

Avoid random, which is irrelevant to furnaces. The holiday feature may be left as an exercise for the reader.

**Pulse and Cycle**
These features are not required and should be off.
6.0 Operation

6.1 Operating Cycle

This product is fitted with an instrument switch which cuts off power to the control circuit.

Connect the product to the electrical supply.

Turn on the instrument switch to activate the temperature controllers. The controllers illuminate and go through a short test cycle.

This product if fitted with a time switch which operates in conjunction with the temperature controller as follows:

<table>
<thead>
<tr>
<th>Temperature Controller</th>
<th>Time Switch Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>301 Controller or 3216CC Controller</td>
<td>Time switch cuts power to the temperature controller</td>
<td>Switch on the instrument switch. Set the required setpoint on the temperature controller. Timer in 'OFF' state: furnace does not heat. Timer in 'ON' state: furnace heats to the setpoint.</td>
</tr>
<tr>
<td>3216 Programmer or 3508 Programmer</td>
<td>Time switch starts a temperature program</td>
<td>Switch on the instrument switch. Set the required temperature program in the temperature controller. Timer in 'ON' state: the program is started. Timer in 'OFF' state: the program is stopped.</td>
</tr>
</tbody>
</table>

Set the time switch as required.

Set the element over-temperature controller to approximately 100 °C above the maximum or setpoint temperature. The element over-temperature controller protects the heating elements from excessive temperature and if activated is self resetting. When correctly set it may be ignored (see section 0.1).

**Chamber Over-Temperature option only.** If the digital over-temperature option has not yet been set as required, set and activate it according to the over-temperature controller instructions.

Unless the time switch is switched off, the product starts to heat up according to the controller setpoint or program.

**Chamber Over-Temperature option only.** If the over-temperature circuit has tripped, an indicator on the over-temperature controller flashes and the heating elements are isolated. Find and correct the cause before resetting the over-temperature controller according to the instructions supplied.
6.0 Operation

To turn the product off, set the instrument switch to its off position. The controller display will go blank. If the product is to be left unattended, isolate it from the electrical supply.

6.2 General Operating Advice

Heating element life is shortened by overheating. Do not leave the product at high temperature when it is not required. The maximum temperature is shown on the product rating label and in section 12.0 towards the back of this manual.

Lightweight ceramic fibre insulation can easily be marked by accidental contact. Some fine cracks may develop in the surface of the insulation due to the progressive shrinkage of the insulation materials. Cracks are not usually detrimental to the functioning or the safety of the product.

Clean up any spillages in the insulation, as these can increase the rate of degradation of the insulation material.

6.3 Operator Safety

This product incorporates a safety switch which interrupts the heating element circuit when the furnace is opened. This prevents the operator touching a live heating element and also prevents the product from heating up if the furnace is left open. The operation of this switch should be checked periodically.

Depending on use, the surfaces in the working chamber and the chamber load may still be very hot after the appliance is switched off. Touching these surfaces may cause burns. Use suitable personal protective equipment or wait until the appliance cools down to ambient temperature.

Before removing a hot object from the product, make sure there is a safe place to put it down. If necessary use tongs, face masks and heat resistant gloves. Heat resistant clothing and face protection can guard against the effects of radiated heat when the furnace is open.

When the product is opened during operation there is considerable radiated heat. Do not keep any flammable objects near the product, nor objects which could be damaged by radiated heat.

6.4 Over-Temperature Control (if fitted)

The over-temperature controller should typically be set at 15 °C above the main controller. If an over-temperature condition occurs, check the main controller is functioning correctly.
An over-temperature condition cuts off power to the heating elements. A light in the over-temperature controller flashes. To reset this, refer to the over-temperature control section of this manual.
## 7.0 Maintenance

### 7.1 General Maintenance

Preventive rather than reactive maintenance is recommended. The type and frequency depends on the product use; the following are recommended.

### 7.2 Maintenance Schedule

<table>
<thead>
<tr>
<th>Maintenance Procedure</th>
<th>Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daily</td>
</tr>
</tbody>
</table>

#### Safety

- **Safety Switch Function**
  - Set a safe temperature above ambient, and open the lid to see if the heater light goes out
  - Electrical measurement

- **Over-Temperature Safety Circuit (if fitted)**
  - Set an over-temperature setpoint lower than the displayed temperature and check for an over-temperature alarm as detailed in this manual
  - Electrical measurement

- **Lid Insulation**
  - Visual inspection, checking the seal and whether it is free of damage

- **Lid Insulation**
  - Replacement where necessary

- **Chimney / Extraction**
  - Check and clean if necessary

- **Electrical Safety (external)**
  - Visual check of external cables and plugs

- **Electrical Safety (internal)**
  - Physically check all connections and cleaning of the power plate area

#### Function

- **Temperature Calibration**
  - Tested using certified equipment, frequency dependent on the standard required

- **Operational Check**
  - Check that all functions are working normally

- **Operational Check**
  - Thorough inspection and report incorporating a test of all functions

---

**DANGER! ELECTRIC SHOCK.** Risk of fatal injury. Only electrically qualified personnel should attempt these maintenance procedures.
### Performance

<table>
<thead>
<tr>
<th>Element Circuit</th>
<th>Electrical measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Consumption</strong></td>
<td>Measure the current drawn on each phase / circuit</td>
</tr>
<tr>
<td>Hearth</td>
<td>Visual check for fit and damage</td>
</tr>
<tr>
<td>Element Protection Tiles</td>
<td>Check for large cracks which could lead to contamination of the elements causing premature failure.</td>
</tr>
<tr>
<td>Hearth and Top Element Protection Tiles</td>
<td>When large gaps form in the element protection tiles they need to be replaced to prevent premature failing of the elements.</td>
</tr>
</tbody>
</table>
7.0 Maintenance

7.2.1 Cleaning

Soot deposits may form inside the furnace, depending on the process. At appropriate intervals remove these by heating as indicated in the General Operation Notes.

The product's outer surface may be cleaned with a damp cloth. Do not allow water to enter the interior of the case or chamber. Do not clean with organic solvents.

7.2.2 Safety Switch

When correctly functioning, the safety switch will isolate all live conductors (live and neutral connections) within the heating element circuit(s) when the product door is opened. The safety switch should be checked regularly to ensure that this occurs.

The safety switch should not fail under normal working conditions, however rough handling, exposure to corrosive materials/environments, or exceptionally frequent use, could compromise the safety system.

**Weekly check:**
The following check can be carried out by a general operator:

- On the temperature controller, set a safe temperature above ambient. The heater lights should illuminate.
- Open the door and check the heater lights. They should no longer be illuminated.

If the heater lights remain illuminated when the door is open, discontinue use and contact Carbolite Gero Service.

**Annual check:**
The following checks should be carried out by a qualified electrician, as specified in the "Maintenance Schedule" section of this manual:

- Remove the element access panel and take a voltage measurement from the heating element terminals. Do not attempt to take a reading from the heating element itself as surface oxidation will give an unreliable contact.
- Ensure that power to the heating elements is switched off when the door is opened.

Contact Carbolite Gero Service and discontinue use of the product if it is found that the heating elements are not fully isolated during these checks.

7.3 Calibration

After prolonged use, the controller and/or thermocouple may require recalibration. This is important for processes that require accurate temperature readings or for those that use the product close to its maximum temperature. A quick check using an independent
thermocouple and temperature indicator should be made from time to time to determine whether full calibration is required. Carbolite Gero can supply these items. Depending on the controller fitted, the controller instructions may contain calibration instructions.

### 7.4 After-Sales Service

Carbolite Gero Service has a team of Service Engineers who can offer repair, calibration and preventive maintenance of furnace and oven products both at the Carbolite Gero factory and at customers’ premises throughout the world. A telephone call or email often enables a fault to be diagnosed and the necessary parts to be despatched.

In all correspondence please quote the serial number and model type given on the rating label of the product. The serial number and model type are also given on the back of this manual when supplied with the product.

Carbolite Gero Service and Carbolite Gero contact information can be found on the back page of this manual.

### 7.5 Recommended Spare Parts and Spare Parts Kit

Carbolite Gero can supply individual spare parts or a kit of the items most likely to be required. Ordering a kit in advance can save time in the event of a breakdown.

Each kit consists of one thermocouple, one sheath, one solid-state relay, one door insulation piece, a set of elements, a set of element clips and a set of braids and clips. Individual spare parts are also available.

When ordering spare parts please quote the model details as requested above.

### 7.6 Element Ageing

Silicon carbide elements gradually increase in resistance with use; a process known as ageing. Their heating power reduces correspondingly. To ensure sufficient power to the product, it may be necessary to adjust the power limit and, ultimately, replace the elements - taking care to readjust the power limit.

If the product does not reach temperature, or is slow, check the power limit setting and increase the value by 5%. It is recommended to make a note of the new settings and the date of the adjustment in section 11.0. Increase the power limit in steps of 5% until the product regains its original performance.

If the power limit is set to 100% a new set of heating elements is required.

Please note: it is not possible to use the cold resistance of the element as a measure of ageing as the cold resistance is not an accurate indicator of hot resistance. Hot resistance is used to calculate furnace power.

See the controller instructions for how to adjust the controller. Always record the setting when first making an adjustment. If new elements are fitted, return the adjustments to the original value. A table of standard power limits is given in section 11.0.
### 7.7 Power Adjustment

The product's control system incorporates electronic power limiting. Power is supplied to the elements in bursts of approximately 0.33 seconds duration. This prevents overheating of the elements. The power limit is programmed into the product controller. A table of standard power limits is supplied with new products, it is given in section 11.0.
8.0 Repairs and Replacements

8.1 Safety Warning - Disconnection from Power Supply

Immediately switch the product off in the event of unforeseen circumstances (e.g. large amount of smoke). Allow the product to return to room temperature before inspection.

Always ensure that the product is disconnected from the electrical supply before repair work is carried out.

Caution: Double pole/neutral fusing may be used in this product.

8.2 Safety Warning - Refractory Fibre Insulation

Insulation made from High Temperature Insulation Wool
Refractory Ceramic Fibre, better known as (Alumina silicate wool - ASW).

This product contains alumino silicate wool products in its thermal insulation. These materials may be in the form of blanket or felt, formed board or shapes, slab or loose fill wool.

Typical use does not result in any significant level of airborne dust from these materials, but much higher levels may be encountered during maintenance or repair.

Whilst there is no evidence of any long term health hazards, it is strongly recommended that safety precautions are taken whenever the materials are handled.

Exposure to fibre dust may cause respiratory disease.

When handling the material, always use approved respiratory protection equipment (RPE-eg. FFP3), eye protection, gloves and long sleeved clothing.

Avoid breaking up waste material. Dispose of waste in sealed containers.

After handling, rinse exposed skin with water before washing gently with soap (not detergent). Wash work clothing separately.

Before commencing any major repairs it is recommended to make reference to the European Association representing the High Temperature Insulation Wool industry (www.ecfia.eu).

Further information can be provided on request. Alternatively, Carbolite Gero Service can quote for any repairs to be carried out either on site or at the Carbolite Gero factory.

8.3 Temperature Controller Replacement

Refer to the controller instructions for more information on how to replace the temperature controller.
8.4 Solid-State Relay Replacement

Disconnect the product from the power supply and remove the appropriate cover as given above.

1. Make a note of the wire connections to the solid state relay, then disconnect them.
2. Remove the solid state relay from the base panel or aluminium plate.
3. Replace and reconnect the solid state relay ensuring that the bottom of it has good thermal contact with the base panel or aluminium plate.
4. Replace the access panel.

8.5 Element Replacement

Unpacking and Handling
Silicon carbide furnace elements will almost certainly be packaged individually and extreme care should be taken when handling them. The elements contained within this furnace are known as Crusilite Double Spiral and the connection points are at one end of the element only.

Installation should only be carried out by a suitably competent electrician or maintenance engineer. Reference should be made to the accompanying Electrical Schematic for details of element configuration and connection.

Procedure

- Identify position of each element.
- If supplied, fit insulation sleeve to counter bore in furnace wall.
- If supplied, fit insulation rings to element.
- Guide element through hole in insulation.
- When inserting the element, please ensure that the ceramic separator plate that protrudes between the element halves is vertical in orientation, this will minimise sagging of the element at high temperatures.
- If applicable, ensure the ‘dump end’ of the element locates in the far end insulation. DO NOT force the elements, they will break!
- Fit the correct braid to each element terminal and secure using the fixings provided.

The element configuration is shown on the Electrical Schematic or on a separate sheet.
If you are unsure of the connections, or problems are encountered, please contact our Service Department.

8.6 Thermocouple Replacement

Disconnect the product from the power supply. Remove terminal cover to gain access to the thermocouple connections. Make a note of the thermocouple connections.

<table>
<thead>
<tr>
<th>thermocouple leg</th>
<th>colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>positive (type R)</td>
<td>orange</td>
</tr>
<tr>
<td>negative</td>
<td>white</td>
</tr>
</tbody>
</table>

Disconnect the thermocouple from its terminal block; retain any porcelain spacers. Withdraw the thermocouple from its sheath and remove any broken bits of thermocouple. Re-assemble with a new thermocouple observing the colour coding. Refit the element access panel.

8.7 Fuse Replacement

Fuses are marked on the wiring diagram with type codes, e.g. F1, F2. For more information on fuses refer to section 11.0.

Depending on model and voltage, the different fuse types may or may not be fitted.

If any fuse has failed, it is advisable for an electrician to check the internal circuits. Replace any failed fuses with the correct type. For safety reasons do not fit larger capacity fuses without first consulting Carbolite Gero.

The fuses are located at the cable entry point. Remove the back panel or control box back panel to gain access to the fuses.
9.0 Fault Analysis

### A. Furnace Does Not Heat Up

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>The HEAT light is ON</strong></td>
<td><strong>The heating element has failed</strong></td>
</tr>
<tr>
<td>2.</td>
<td><strong>The HEAT light is OFF</strong></td>
<td><strong>The controller shows a very high temperature or code such as S.br</strong></td>
</tr>
<tr>
<td></td>
<td><strong>The controller shows a low temperature</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>There are no lights glowing on the controller</strong></td>
<td><strong>Check the supply fuses and any fuses in the furnace control compartment</strong></td>
</tr>
</tbody>
</table>
### B. Product Overheats

<table>
<thead>
<tr>
<th></th>
<th>Product only heats up when the instrument switch is ON</th>
<th>The controller shows a very high temperature</th>
<th>The controller is faulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>The controller shows a low temperature</td>
<td>The thermocouple may be faulty or may have been removed out of the heating chamber</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The thermocouple may be connected the wrong way around</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The controller may be faulty</td>
</tr>
<tr>
<td>2</td>
<td>Product heats up when the instrument switch is OFF</td>
<td>The SSR has failed &quot;ON&quot;</td>
<td>Check for an accidental wiring fault that could have overloaded the SSR</td>
</tr>
</tbody>
</table>
10.0 Wiring Diagrams

For wiring diagrams, please contact Carbolite Gero Service. Please quote the serial number and model.
11.0 Fuses and Power Settings

11.1 Fuses

F1-F3: Refer to the circuit diagrams.

<table>
<thead>
<tr>
<th></th>
<th>Internal Supply Fuses</th>
<th>Fitted if supply cable fitted. Fitted on board to some types of EMC filter.</th>
<th>GEC Safeclip of the type shown (glass type F up to 16 A) 38 mm x 10 mm type F fitted on EMC filter circuit board(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td>Auxiliary Circuit Fuses</td>
<td>Fitted on board to some types of EMC filter. May be omitted up to 25 Amp/phase supply rating.</td>
<td>2 Amps glass type F On board: 20 mm x 5 mm Other: 32 mm x 6 mm</td>
</tr>
<tr>
<td>F3</td>
<td>Heat Light Fuses</td>
<td>May be omitted up to 25 Amp/phase supply rating.</td>
<td>2 Amps glass type F 32 mm x 6 mm</td>
</tr>
</tbody>
</table>

| Customer Fuses | Required if no supply cable fitted. Recommended if cable fitted. | See rating label for current; See table below for fuse rating. |

Access to internal fuses is by opening the front door panel.

<table>
<thead>
<tr>
<th>Model</th>
<th>Phases</th>
<th>Volts</th>
<th>Supply Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCF 1</td>
<td>3-phase Delta</td>
<td>200-240</td>
<td>32 A</td>
</tr>
<tr>
<td>SCF 1</td>
<td>3-phase + N</td>
<td>380-415</td>
<td>32 A</td>
</tr>
</tbody>
</table>

11.2 Power Settings

The power limit settings (parameter OP.Hi) for this model are voltage dependant. The figures represent the maximum percentage of time that controlled power is supplied to the elements. Do not attempt to “improve performance” by setting a value higher than the recommended values. To adjust the parameter refer to the "Changing the Maximum Output Power" of the control section of the manual.

For fuse ratings, please contact Carbolite Gero Service. Please quote the serial number and model.

<table>
<thead>
<tr>
<th>Volts (v)</th>
<th>220 V</th>
<th>230 V</th>
<th>380 V</th>
<th>400 V</th>
<th>415 V</th>
</tr>
</thead>
</table>

Please refer to the rating label for product specific information.
12.0 Specifications

Carbolite Gero reserves the right to change the specification without notice.

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Temp (°C)</th>
<th>Max Power (kW)</th>
<th>Chamber Size H x W x D (mm)</th>
<th>External Dimensions (excluding handles) H x W x D (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCF 1</td>
<td>1400</td>
<td>15.0</td>
<td>440 x 285 x 285</td>
<td>850 x 905 x 905</td>
</tr>
</tbody>
</table>

12.1 Environment

The models listed in this manual contains electrical parts and should be stored and used in indoor conditions as follows:

Temperature: 5 °C - 40 °C

Relative humidity: Maximum 80 % up to 31 °C decreasing linearly to 50 % at 40 °C
## Service Record

<table>
<thead>
<tr>
<th>Engineer Name</th>
<th>Date</th>
<th>Record of Work</th>
</tr>
</thead>
<tbody>
<tr>
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</table>
The products covered in this manual are only a small part of the wide range of ovens, chamber furnaces and tube furnaces manufactured by Carbolite Gero for laboratory and industrial use. For further details of our standard or custom built products please contact us at the address below, or ask your nearest stockist.

For preventive maintenance, repair and calibration of all furnace and oven products, please contact:

**Carbolite Gero Service**

Telephone: + 44 (0) 1433 624242  
Fax: +44 (0) 1433 624243  
Email: ServiceUK@carbolite-gero.com

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**Carbolite Gero Ltd,**  
Parsons Lane, Hope, Hope Valley, S33 6RB, England.  
Telephone: + 44 (0) 1433 620011  
Fax: + 44 (0) 1433 621198  
Email: Info@carbolite-gero.com  
www.carbolite-gero.com

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